# Space Weather Technical Forecast

Issued on Tuesday, 07 May 2024 at 12:29 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Occasional M-class flares expected with a chance of isolated X-class flares. Chance of G1/Minor storm intervals due to CMEs (Coronal Mass Ejections).**

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Solar activity is at High levels. AR3663 has produced numerous M-flares in the last 24 hours, peaking M5.1 at 07/0616 UTC. There are nine sunspot regions on the visible disc, with the region in the far northeast now numbered AR3670. AR3663 remains the most active flaring region, retaining a small delta spot on the interior of the group, although there appears to have been some slight decrease in penumbral area. AR3664 is now the largest region on the disc and has evolved rapidly with the emergence of a number of strong spots in the trailing portion of the group along with numerous delta configurations. Classification is somewhat complicated by the proximity of AR3668 to the east, though this is designated a simpler bipolar region at this time. The remaining sunspots on the disc are smaller, stable and magnetically simple.

A broad dimming in the vicinity of AR3664 starting around 07/0000 UTC in SDO/AIA 211 imagery looks to have resulted in a CME. Analysis is ongoing to determine if there is an Earth-directed component to it.

**Solar Wind / Geomagnetic Activity:** Solar winds observed by ACE at L1 were at predominantly slightly elevated to elevated levels resulting from the connection to the HSS of one or more positive coronal holes. Speeds peaked briefly at strong levels (602km/s at 07/0150 UTC). Density declined from mostly average levels to below average through the period. The Interplanetary Magnetic Field, Bt, remained mainly at moderate levels initially before declining to weak levels around 06/1730 UTC. The peak was around 12nT at 06/1313 UTC. The north-south component, Bz, was very variable but declined from moderate to weak levels, ranging between +10/-10nT. Phi angle was mostly positive (away from the sun). Geomagnetic activity was Quiet to Active (Kp 1-4).

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV) observed at GOES18 was at normal background levels. High energy electron flux (greater than 2MeV) observed at GOES16 remained at largely background levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 07/0001UTC was 1.38e6 integrated pfu on a steady trend.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Moderate to High solar activity is forecast to continue with occasional M-flares expected and a chance of isolated X-flares, principally from AR3663 and AR3664.

**Solar Wind / Geomagnetic Activity:** There are multiple potential Earth-directed CMEs in the forecast period, although confidence is low due to a lack of coronagraph imagery in recent days. Of these, the majority, if not all are expected to pass above or below Earth orbit, most likely limiting any impacts to glancing blows. Earth is under the influence of a HSS (High speed stream) from CH35/+ and/or CH33/+ which is expected to peak at elevated levels on Day 1 (07

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May) before slowly declining between Days 2-4 (08-10 May) towards slightly elevated or background levels.

Geomagnetic activity should generally fall between Quiet to Active levels through the period, but with a chance of Minor Storm (Kp5) intervals on all days, given the potential for peripheral CME enhancements.

**Energetic Particles / Solar Radiation:** High energy proton flux is likely to remain at background levels through the period. There is a chance for an S1/Minor Storm or greater event throughout however, primarily from AR3663.

High energy electron flux is forecast to be at background to moderate levels throughout, with associated fluence expected to remain well below the Active (1e8 integrated pfu) threshold.

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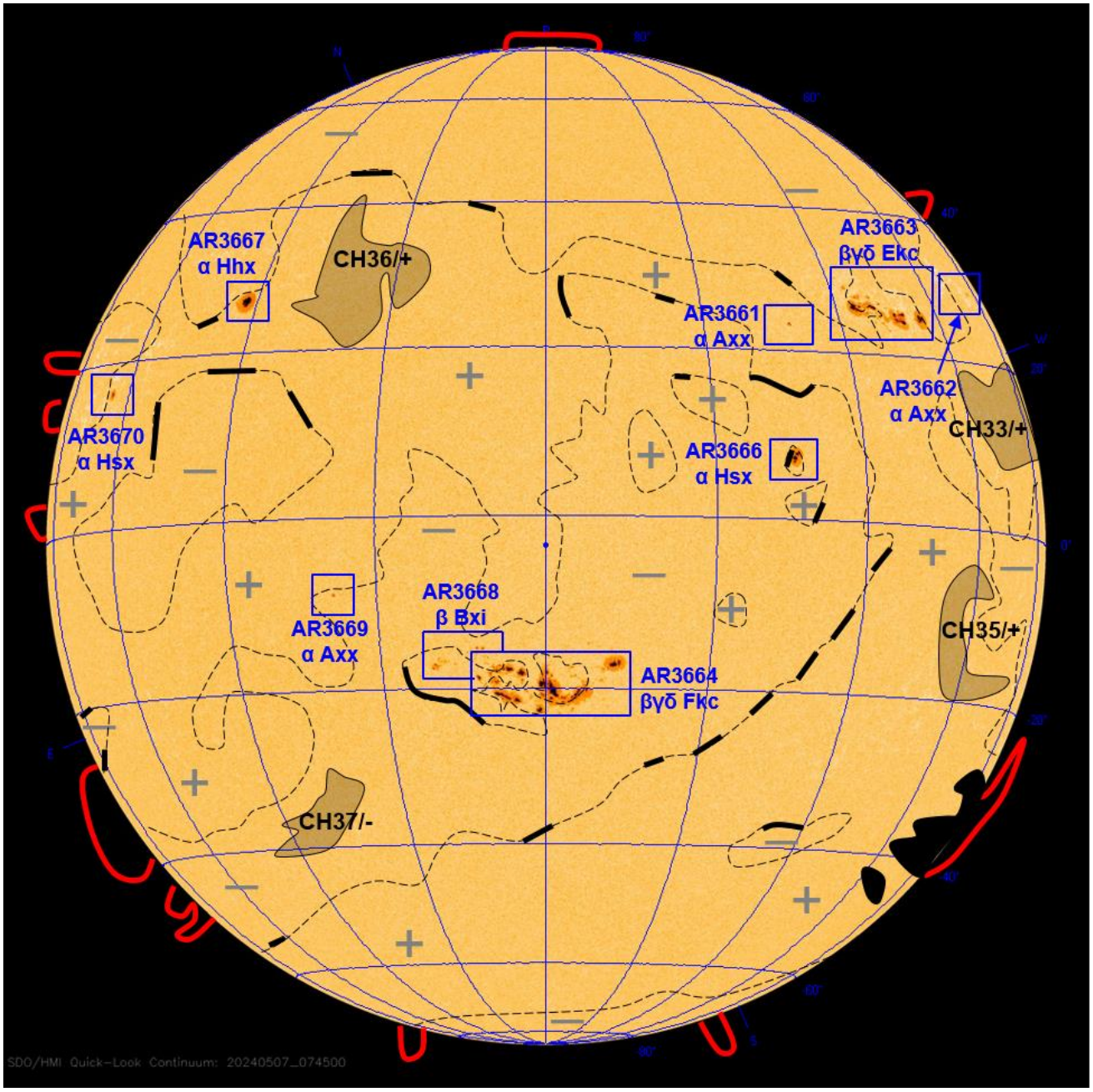
**Figure 1. Solar Analysis Valid 07/0745 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are multiple potential Earth-directed CMEs in the forecast period, although confidence is low due to a lack of SOHO imagery in recent days. A largely northward directed CME followed the M9.0 flare of AR3663 early on 05 May, with modelling giving a possible glancing interaction late Day 1 (07 May) or early Day 2 (08 May). Another mostly northbound CME in association with the X4.5 flare on 06 May has the potential to have a small Earth-directed component and cause an impact late on Day 3 (09 May). This may arrive at a similar time to a small CME from a filament eruption in the southwest disc that left the Sun late on 05 May. Further analysis is required of a coronal dimming in the southeast disc near AR3664 around 05/1500 UTC that led to a CME, as well as another CME from the same region early on 07 May.

Earth is presently connected to a HSS from coronal holes CH33/+ and CH35/+, giving elevated solar wind speeds. The coronal holes while broadly persistent are noticeably larger than the previous rotation with elevated solar winds that should peak today (07 May) before easing in the coming days towards slightly elevated or background levels. The combination of coronal hole and potential CME influence through the period, as well as gaps in imagery, results in a lower than average geomagnetic forecast confidence.

Geomagnetic activity should generally fall between Quiet to Active levels through the period, but with a chance of Minor Storm (Kp5) intervals on all days, given the potential for peripheral CME enhancements.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 20 | 20 | 20 | 20 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 04/0715 | Partial | AR3664 | NW | 601 km/s | 08/0000 UTC | Glance possible |
| 06/1056 | Partial | AR3664 | NW | 811 km/s | 09/0600 UTC | Glance possible |
| 06/1451 | Partial | Filament | SW | 927 km/s | 09/0200 UTC | Glance possible |

**Figure 2: Latest MOSWOC Enlil ensemble forecast**

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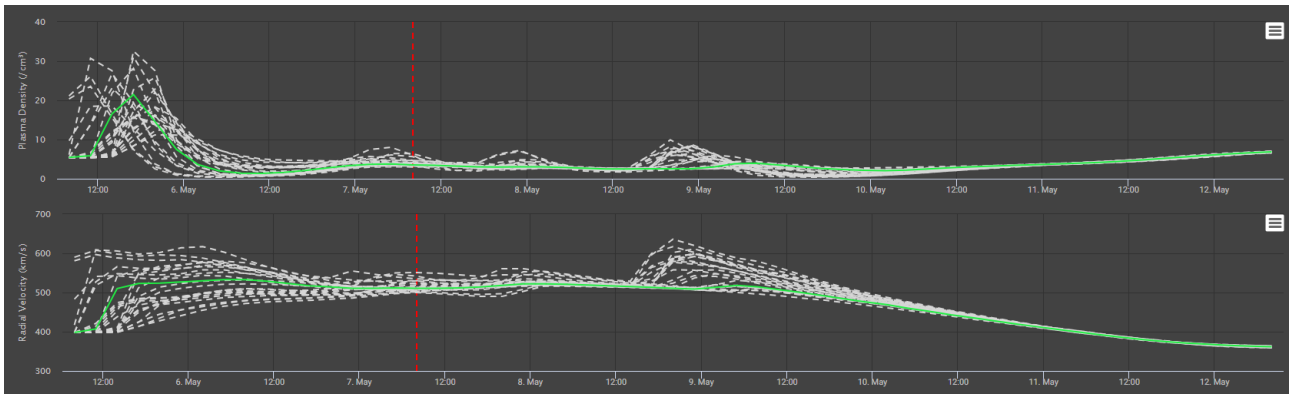


## Radio Blackouts - X-Ray Flares:

Solar activity is High with the largest flare observed an M5.1 at 07/0616 UTC and numerous lower M-class flares, all from AR3663.

There are currently nine sunspot regions on the visible disc. The most active remains AR3663, located in the northwest, and features a large and complex intermediate spot with a delta configuration. There has been some recent indications of weakening however, with a slight reduction in areal extent. AR3664 near south-centre disc is now the largest spot on the disc. There has been marked growth in the region during the past 24 hours, particularly in the east of the group with the emergence of a number of strong spots and multiple delta configurations. The east of the region lies close to AR3668 and appears magnetically linked. Despite this AR3664 has not been as flare productive as AR3663 to this point.

The remaining sunspots on the disc are generally smaller, stable and magnetically simple. Both AR3663 and AR3664 remain on the visible disc for much of the guidance period until Day 4 (10 May) when the former rotates over the northwest horizon. Far-sided helioseismographs indicate a number of returning regions over the eastern horizon in the coming days that may supplement the present risk of significant flares should they persist.

Moderate to High solar activity is expected to continue, pending further developments, with occasional M-class flares and a chance of isolated X-class flares throughout, principally from AR3663 and AR3664.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 95 | 95 | 90 | 90 |
| Very Active | R3 to R5 X Class | No | 45 | 45 | 40 | 40 |

**Figure 3: GOES-16 X-Ray flux**

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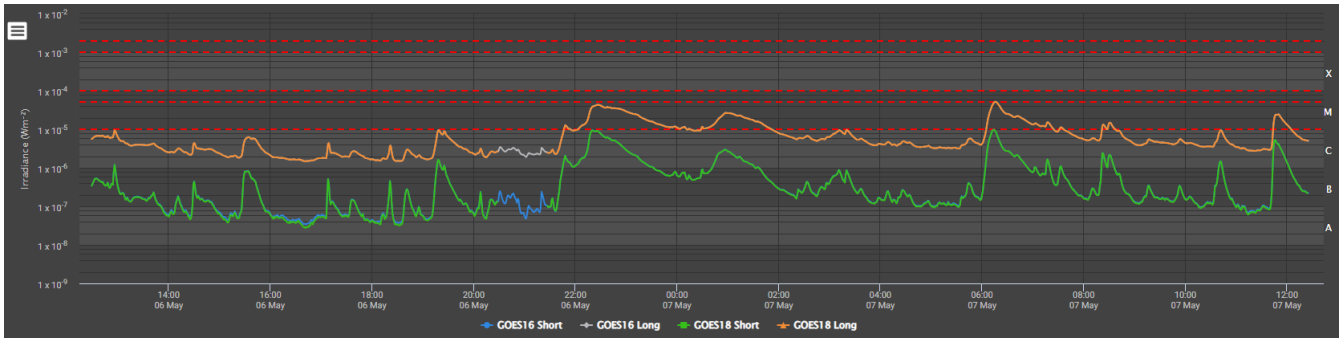


## Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) observed at GOES-18 has been at background levels and is most likely to remain that way through the period. However, there is a chance of an S1/Minor Storm or greater event occurring throughout, primarily from AR3663 as it transits westward, although recent significant flares from this region have so far failed to trigger any significant proton response.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 25 | 25 | 30 | 30 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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### High Energy Electrons Event (≥ 2MeV):

High energy electron flux is at normal background levels. Likely CME and coronal hole influences through the period are expected to limit electron flux to background to moderate levels on all days.

Overall, the 24 hour integrated electron fluence is forecast to remain well below the Active (1e8 integrated pfu) threshold.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 1 | 1 | 5 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

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